Encouraging Creativity in the Science Lab

A series of activities designed to help students think outside the box

Linda Eyster

Although science is a creative endeavor (NRC 1996, p. 46), many students think they are not encouraged—or even allowed—to be creative in the laboratory. When students think there is only one correct way to do a lab (Figure 1), their creativity is inhibited. Park and Seung (2008) argue for the importance of creativity in science classrooms and for the teacher's role in enhancing students' creativity. This article describes several quick, inexpensive ways to encourage creativity and problem-solving skills in the lab.

Solve It!

"Solve It" activities are quick ways to address the student misconception that there is only one solution to a lab problem. When students get stuck during an experiment, I take note and use these examples for problem-solving practice the following year.

The Solve It activity in Figure 2 (p. 34), for example, presents an actual class event. A student of mine wanted to germinate seeds in petri dishes lined with paper towels. He placed the dishes upright in bowls with varying pH levels; however, some of his seeds fell into the water and did not germinate. He thought that I knew "the trick" to keep the seeds from submerging, but there are actually several ways to accomplish this (see photo). By presenting students with real-life scenarios and asking them to brainstorm ways to solve such problems, they learn that there is more than one way to solve a problem. Asking students to brainstorm multiple ideas also shows them that I value their creativity.

Using a common procedural stumbling block for an experiment encourages students to try out their ideas in an authentic context (Figure 2). Some ideas might seem useful, until they are tested. Others may not be worth trying, but can stimulate a related, more viable idea. The key to being a creative problem solver is to not judge ideas as they materialize, as the act of judging can inhibit creative thinking.

Creativity, as a group

Lab groups can benefit from practice working independently, even during teacher-selected inquiries. Letting students design all or part of their lab procedures can spark creative potential and ownership. So, for some labs, I set up trifold cardboard dividers between lab groups to encourage their creativity. This way, students cannot readily see and copy what other groups are doing.

FIGURE 1

Misconceptions that inhibit creativity.

- "There is only one correct procedure for this lab."
- "My teacher knows the correct procedure."
- "My teacher knows the correct equipment needed for this lab."
- "My teacher knows the only correct outcome for this lab."
- "If I do not have step-by-step instructions, then I have to discover the correct procedure and use the correct equipment to get the correct answer."
- "All of the equipment has a predetermined use."

PHOTO COURTESY OF THE AUTHOR

One possible petri dish setup to keep seeds from falling into the water.

When student groups are separated by cardboard dividers, they realize that I value their independent thought, and classes are more likely to end up with a variety of methods to address the assigned topic. For example, when studying the impact of abiotic factors on yeast respiration (Knabb and Misquith 2006), one group might stopper a flask with an air lock loaded with a universal indicator; another might let the gas bubbles escape into a tube of bromothymol blue (BTB); and a third group might collect the gas by displacing water in an inverted tube. All three variations are useful approaches.

Once groups have tested out and finalized their procedures, they briefly share their ideas with the class, and students note that there are multiple ways to address the same question. (**Safety note:** I constantly walk from station to station during these labs—keeping an eye on behavior, giving tips if a group is stuck, and providing requested lab supplies. Although the cardboard dividers can stand on their own, I stabilize them by duct-taping them to each other and the lab bench.)

CAUTION

"What is this for?"

For some inquiry labs, I preset each station with materials. When I first started doing this, students would often hold something up and ask me, "What is this for?" These comments made me realize that they thought each item had a predetermined use for that lab.

Once I was aware of this misconception—which inhibited students' ability to be inventive and independent—I began to set out three categories of items: essential items, materials that students might find useful, and items selected haphazardly from the lab or my home (Figure 3). After I have selected the materials, I set them at the stations. Students are told that they may use any materials at their stations, but they soon realize that each item does not need to be used. To be fair, I give each group the same items set in the same arrangement. I have found that an item's placement on the lab bench can affect whether or not it is used.

This is an easy modification for lab setups, and over the past decade, I have enjoyed watching the interesting and productive ways students use the randomly selected items. For example, I have seen students bundle pennies with rubber bands to anchor dialysis bags, use keys to prop up marshmallows for better air circulation during calorimetry, and use red stickers to assess enzyme activity (the stickers tested positive with iodine for starch before exposure to active enzyme, and negative after exposure to certain enzyme levels). For safety's sake, I always approve student procedures before they are used in the actual investigation.

FIGURE 2

Sample "Solve It" activity.

Instructions:

1. Read the paragraph below:

   A student wants to study the impact of acid rain on seed germination for his chemistry experiment. He lines three petri dishes with damp circles of paper towels and places corn seeds in a horizontal row across each dish. He places the tops on the petri dishes and stands them upright in a bowl containing shallow water with a pH of 4. He then sets up three more dishes and stands them in shallow water with a pH of 7. He leaves the petri dishes in the lab for several days and, as expected, the paper towels absorb the water and keep the seeds moist. However, some seeds fall off of the paper towels into the water at the bottom of the petri dish; these seeds do not germinate. The student still wants to germinate his seeds in petri dishes but needs help keeping his seeds from falling into the water.

2. Restate the problem with your partner. Be sure that you agree on the specific problem to be solved.
3. Brainstorm at least five ways to solve the problem. Do not judge any ideas until you finish brainstorming.

Sample student solutions:

- Use smaller seeds.
- Wet or soak the seeds ahead of time.
- Sand the seeds with sandpaper.
- Tip each petri dish so it is not completely vertical.
- Bunch the paper towel so it forms a speed bump–like ledge under the seeds (see photo, p. 33).
- Before you wet the paper towel, attach the seeds with tape.
- Lay each petri dish flat instead of upright, and add a felt wick to bring the pH-adjusted water from the source container into the dish.
- Put another layer of paper towels on top of the seeds (i.e., like a seed sandwich).
- Decrease the amount of water in the bowl.

What's my line?

Over the years, I have listened to students struggling in a lab—to improve their experimental design, control variables, or work better as a group—and often wished I could talk into a student's ear and have him or her repeat what I said. Instead, I decided to write down (on index cards) some of the questions that I want students to ask when they are not being productive (Figure 4). As the occasion arises, I hand an appropriate card to a student, who must read the question aloud to partners as if it is his or her own thought. Groups respond productively to these questions and move forward with their work. Conversation starters, such as these, can be used for any level class to refocus students. I have even heard students (jokingly) recite some of the questions during later lab work—and it still helped focus the group.

When I hand out the "Do we have a use for this?" card, I pick up an item at the station that students have not con-

FIGURE 3

Types of items provided at preset lab stations.

1. Items that students will find essential (e.g., seeds in a germination lab).
2. Items that students might find useful (e.g., if students need to measure water, I might provide two beakers [100 ml and 250 ml] and two graduated cylinders [10 ml and 100 ml] so that they can consider the pros and cons of each).
3. Items that students might invent uses for (e.g., paper clips, rubber bands, stickers, pennies, or keys).

FIGURE 4

Sample conversation starters.

- "Do we have a use for this?"
- "What do we know for sure?"
- "What are we supposed to be doing?"
- "What are we trying to figure out?"
- "What is our main problem right now?"
- "How can we solve our main problem?"
- "What are the main variables that might be impacting our data?"
- "Which of our top 10 variables are we not controlling well?"
- "How do we know if we have enough data?"
- "How should we budget the time we have left?"
- "Have we waited long enough?"
- "What should we do next?"

sidered using. For example, if I overhear students complaining that they wish they could keep the temperature of their chemical reaction warmer, I hand them the card with a small bucket from their station. This might trigger one student to say, "Oh, we could put the test tubes into hot water in the bucket." Students know that a water bath provides a more stable temperature than air, that the bucket can hold plenty of water, and that multiple test tubes can fit in the bucket, but they do not always connect their knowledge.

I now encourage students to practice this on their own by picking up an unused item and asking, "Do we have a use for this?" It is a simple question that sparks the group's creative energy.

"What do we know for sure?" is another valuable question, but one that students do not tend to ask one another. When handed to students, this card not only refocuses the group, but allows them to summarize what they have completed, consider what needs to be done, and sort useful data from misleading information.

To help avoid unintentional biases as to who in the group receives the card (e.g., a student who is male or female, talkative or quiet, engaged or indifferent, and so on) I always hand it to the group member on my left. If that group receives a second card, I hand that card to the student to the left of the student who received the first card, and so on.

Conclusion

Businesses say that they want to hire creative employees, but 70% report deficient problem-solving skills in their recently hired high school graduates (Casner-Lotto and Barrington 2006). A chief administrator of Syngenta, a global agribusiness company, recently said, "Innovation comes from realizing that research can only advance if we have innovative people to advance it, and if we give them time and space to innovate" (Bonetta 2009, p. 162). It seems that the same may be true for our classrooms. The activities described in this article are productive and fun ways to incorporate creativity in the classroom. They have encouraged me to start thinking about additional ways to support divergent thinking. I am now collaborating with a colleague in the drama department to adapt improvisation games to further encourage creativity in the lab—where students may least expect to find it! ■

Linda Eyster (linda_eyster@milton.edu) *is a science teacher and Pratt teaching chairholder at Milton Academy in Milton, Massachusetts.*

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